Beyond ACLS - Cardiac Arrest for the Resuscitationist

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EMS Fellow
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Disclosures
Objectives

• How to manage intra-arrest
• How to manage post-arrest
• How to manage recurrent/refractory arrhythmia
• How to optimize neurologic resuscitation
• How to manage intra-arrest in the future
Clinical paper

Out-of-hospital cardiac arrest survival improving over time: Results from the Resuscitation Outcomes Consortium (ROC) study

Mohamud R. Daya, Robert H. Schmicker, Dana M. Zive, Thomas D. Rea, Graham Nichol, Jason F. Ruick, Steven Brooks, Tim Christenson, Renee MacPhee, Alan Craig, Jon C.

Henry Wang, for the


Fig. 2. Out of hospital cardiac arrest survival over time – all sites and rhythm groups.
Advanced Cardiac Arrest
Advanced Cardiac Arrest
Medic phone rings…
What do you do?
Patient Arrival

- CPR Ongoing
- PMHx – HTN
- Meds – HCTZ
- All – NKDA
- Current rhythm
INTRA ARREST MANAGEMENT
Survival rates in out-of-hospital cardiac arrest patients transported without prehospital return of spontaneous circulation: An observational cohort study

Ian R. Drennan, Steve Lin, Daniel E. Sidalak, Laurie J. Morrison

Rescu, Li Ka Shing Knowledge Institute, St. Michael’s Hospital, Toronto, Canada
Institute of Medical Science, Department of Medicine, University of Toronto, Toronto, Canada
York Region Emergency Medical Services, Ontario, Canada
Division of Emergency Medicine, Department of Medicine, University of Toronto, Toronto, Canada
AIRWAY MANAGEMENT
Airway

- Intubate?
- NRB at 15 LPM?
- Supraglottic airway?
- BVM with oral airway?
- Nothing?
- Ventilator?
Actual Management

**OOH**
- Bystander
  - Nothing
- EMT
  - BVM
- Paramedic
  - ETI

**ED**
- ETI

—I regret nothing.

Nothing.
### Advanced Airway Management Does Not Improve Outcome of Out-of-hospital Cardiac Arrest

M. Arslan Hanif, MD, Amy H. Kaji, MD, PhD, and James T. Niemann, MD

Table 2: Univariate and Multivariable Analysis for BVM/ETI for SHD

<table>
<thead>
<tr>
<th>Predictor Variable for SHD</th>
<th>Univariate OR (95% CI)</th>
<th>Multivariable OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVM vs. ETI</td>
<td>3.30 (1.8–6.3) p = 0.0002</td>
<td>4.5 (2.3–8.9) p &lt; 0.0001</td>
</tr>
<tr>
<td>VT/VF vs. all other rhythms</td>
<td>8.60 (2.7–27.9) p &lt; 0.0001</td>
<td>9.3 (2.6–33.4) p = 0.0006</td>
</tr>
<tr>
<td>Witnessed vs. unwitnessed</td>
<td>4.10 (2.2–7.7) p &lt; 0.0001</td>
<td>9.5 (2.8–11.1) p &lt; 0.0001</td>
</tr>
<tr>
<td>Bystander CPR vs. no bystander CPR</td>
<td>1.20 (0.7–2.0) p = 0.6</td>
<td>1.5 (0.8–2.7) p = 0.2</td>
</tr>
<tr>
<td>Nursing home vs. all other sites of arrest</td>
<td>0.40 (0.2–0.9) p = 0.03</td>
<td>0.4 (0.2–0.9) p = 0.03</td>
</tr>
<tr>
<td>Male vs. female</td>
<td>0.90 (0.6–1.6) p = 0.9</td>
<td>0.9 (0.5–1.6) p = 0.7</td>
</tr>
<tr>
<td>Age</td>
<td>0.99 (0.97–1.00) p = 0.3</td>
<td>1.0 (0.98–1.02) p = 0.9</td>
</tr>
</tbody>
</table>

BVM/ETI = bag-valve-mask ventilation/endotracheal intubation; CPR = cardiopulmonary resuscitation; SHD = survival to hospital discharge; VF/VT = ventricular fibrillation/ventricular tachycardia.
### Table 3. Multivariable Logistic Regression Analysis of the Association of Survival to Discharge (Ventricular Fibrillation/Ventricular Tachycardia)

<table>
<thead>
<tr>
<th>Intubation status</th>
<th>Survival to Discharge Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETI</td>
<td>0.52 (0.27, 0.998)</td>
</tr>
<tr>
<td>No ETI</td>
<td>1.00</td>
</tr>
<tr>
<td>Witnessed cardiac arrest</td>
<td>2.75 (1.36, 5.56)</td>
</tr>
</tbody>
</table>

Goodness of fit: Hosmer-Lemeshow. Ventricular fibrillation/ventricular tachycardia. P = 0.92. CI = confidence interval; ET = endotrachea

### Table 4. Logistic Regression Analysis of the Association of Survival to Admission with Sample Characteristics in Patients Who Did Not Have Ventricular Fibrillation/Ventricular Tachycardia (n = 742)

<table>
<thead>
<tr>
<th>Intubation status</th>
<th>Prevalence (% Survived to Admission)</th>
<th>OR (95% CI)</th>
<th>Prevalence (% Survived to Discharge)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETI</td>
<td>13.5</td>
<td>2.94 (1.16, 7.44)</td>
<td>1.8</td>
<td>1.83 (0.23, 14.26)</td>
</tr>
<tr>
<td>No ETI</td>
<td>5.0</td>
<td>1.00</td>
<td>1.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Age &lt;80 years</td>
<td>11.3</td>
<td>0.88 (0.53, 1.46)</td>
<td>1.5</td>
<td>0.81 (0.22, 3.02)</td>
</tr>
<tr>
<td>Age 80+ years</td>
<td>12.7</td>
<td>1.00</td>
<td>1.8</td>
<td>1.00</td>
</tr>
<tr>
<td>Witnessed cardiac arrest</td>
<td>14.8</td>
<td>2.68 (1.46, 4.91)</td>
<td>1.5</td>
<td>0.95 (0.25, 3.57)</td>
</tr>
<tr>
<td>No</td>
<td>6.1</td>
<td>1.00</td>
<td>1.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Location</td>
<td>13.1</td>
<td>1.36 (0.78, 2.39)</td>
<td>2.1</td>
<td>3.63 (0.46, 28.28)</td>
</tr>
<tr>
<td>Home</td>
<td>9.9</td>
<td>1.00</td>
<td>0.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Other</td>
<td>9.9</td>
<td>0.72 (0.35, 1.51)</td>
<td>0.00</td>
<td>—</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>13.2</td>
<td>1.00</td>
<td>1.8</td>
<td>—</td>
</tr>
</tbody>
</table>

CI = confidence interval; CPR = cardiopulmonary resuscitation; ET = endotracheal intubation; OR = odds ratio.

Assessing Impact of PreHospital Intubation on Survival from OOHCA
Egly et al. PEC. Jan 2011.
 Interruptions in Cardiopulmonary Resuscitation From Paramedic Endotracheal Intubation

Annals of EM
Association of Prehospital Advanced Airway Management With Neurologic Outcome and Survival in Patients With Out-of-Hospital Cardiac Arrest

Kohei Hasegawa, MD, MPH
Atsushi Hiraide, MD, PhD
Yuchiao Chang, PhD
David F. M. Brown, MD

Importance It is unclear whether advanced airway management such as endotracheal intubation or use of supraglottic airway devices in the prehospital setting improves outcomes following out-of-hospital cardiac arrest (OHCA) compared with conventional bag-valve-mask ventilation.
Advanced Cardiac Arrest

Figure 2. Results of Conditional Logistic Regression Models Using One of the End Points as a Dependent Variable With Propensity-Matched Patients

A. Endotracheal intubation vs bag-valve-mask ventilation

| Model Total | Total No. of Patients | Endotracheal Intubation (%) | Bag-Valve-Mask Ventilation (%) | Odds Ratio (95% CI) *
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted</td>
<td>35722B</td>
<td>1734 (6.7)</td>
<td>14824 (5.3)</td>
<td>0.76 (0.71-0.81)</td>
</tr>
<tr>
<td>Adjusted for selected variables²³</td>
<td>35722B</td>
<td>1069 (4.1)</td>
<td>10373 (5.8)</td>
<td>0.70 (0.65-0.76)</td>
</tr>
<tr>
<td>Adjusted for all variables²⁴</td>
<td>35722B</td>
<td>257 (1.0)</td>
<td>5790 (3.2)</td>
<td>0.31 (0.27-0.35)</td>
</tr>
</tbody>
</table>

B. Supraglottic airway vs bag-valve-mask ventilation

| Model Total | Total No. of Patients | Supraglottic Airway (%) | Bag-Valve-Mask Ventilation (%) | Odds Ratio (95% CI) *
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted</td>
<td>35722B</td>
<td>6933 (4.5)</td>
<td>14824 (5.3)</td>
<td>0.53 (0.51-0.54)</td>
</tr>
<tr>
<td>Adjusted for selected variables²³</td>
<td>35722B</td>
<td>5718 (3.9)</td>
<td>10373 (5.8)</td>
<td>0.62 (0.61-0.69)</td>
</tr>
<tr>
<td>Adjusted for all variables²⁴</td>
<td>35722B</td>
<td>1697 (1.1)</td>
<td>5790 (3.2)</td>
<td>0.33 (0.32-0.35)</td>
</tr>
</tbody>
</table>

Full models for the primary outcome analysis are included in eTable 2.

* For all odds ratios, P < .001.

²³Selected variables are a predefined set of potential confounders including age, sex, cause of cardiac arrest, first documented rhythm, bystander witness, type of cardiopulmonary resuscitation (CPR) initiated by a bystander, use of public access automated external defibrillator by bystander, epinephrine administration, time from receipt of call to CPR by emergency medical service, and time from receipt of call to hospital arrival.

²⁴All variables included all covariates in Table 1 and variables for 47 prefectures in Japan.
BREATHING

*SEE'S CHOCOLATE ICE CREAM*

(heavy breathing)
Incidence of Agonal Respirations in Sudden Cardiac Arrest

Jill J Clark*
Mary Pat Larsen, MS*
Linda L Culley*
Judith Reid Graves, RN, MA*
Mickey S Eisenberg, MD, PhD**

Study objective: To discover the frequency of agonal respirations in cardiac arrest calls, the ways callers describe them, and discharge rates associated with agonal respirations.

Design: We reviewed taped recordings of calls reporting cardiac arrests and emergency medical technician and paramedic incident reports for 1991. Arrests after arrival of emergency medical services were excluded.

Setting: King County, Washington, excluding the city of Seattle.

Participants: Four hundred forty-five persons with out-of-hospital cardiac arrests receiving emergency medical services.

Interventions: Telephone CPR, emergency medical technicians-defibrillation, and advanced life support by paramedics.

Measurements and main results: Any attempts at breathing described by callers were identified, as well as whether agonal respirations could be heard by dispatcher, emergency medical technicians, or paramedics. Agonal respirations occurred in 40% of 445 out-of-hospital cardiac arrests. Callers described agonal breathing in a variety of ways. Agonal respirations were present in 46% of arrests caused by cardiac etiology compared with 32% in other etiologies ($P<.01$). Fifty-five percent of witnessed arrests had agonal activity compared with 16% of unwitnessed arrests ($P<.001$). Agonal respirations occurred in 56% of arrests with a rhythm of ventricular fibrillation compared with 34% of cases with a nonventricular fibrillation rhythm ($P<.001$). Twenty-seven percent of patients with agonal respirations were discharged alive compared with 9% without them ($P<.001$).

Conclusion: There is a high incidence of agonal activity associated with out-of-hospital cardiac arrest. Presence of agonal respirations is associated with increased survival. These findings have implications for public CPR training programs and emergency dispatcher telephone CPR programs.

Gasper during cardiac arrest
Mathias Zuercher\textsuperscript{a} and Gordon A. Ewy\textsuperscript{b,c}

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Tel: +41 61 328 73 80; fax: +41 61 265 73 20; e-mail: mzuercher@uhbs.ch

Current Opinion in Critical Care 2009, 15:185–188

Purpose of review
The purpose of this study is to review the prevalence and significance of gasping in patients experiencing cardiac arrest.

Recent findings
In a recent study by Bobrow et al., gasping was identified in 33\% of patients who arrested after the arrival of emergency medical services (EMS). Patients who arrested previous to EMS arrival experienced a decreasing incidence of gasping with increasing duration of cardiac arrest: 20\% if EMS arrived within 7 min, 14\% if EMS arrival was between 7 and 9 min, and 7\% if EMS arrived after 9 min. There was a positive association between the presence of gasping and survival: 28\% of those who gasped survived compared with 8\% of those who did not gasp (odds ratio, 3.4, 95\% confidence interval, 2.2–5.2). Among the 481 patients who received bystander cardiopulmonary resuscitation, survival to hospital discharge occurred among 39\% of patients who gasped versus 9\% among those who did not gasp (adjusted odds ratio, 5.1, 95\% confidence interval, 2.7–9.4).

Summary
Gasper frequently occurs during cardiac arrest. Public and emergency medical dispatchers must be more aware of its presence and significance.
Hyperventilation-Induced Hypotension During Cardiopulmonary Resuscitation

Tom P. Auferheide, MD; Gardar Sigurdsson, MD; Ronald G. Firrallo, MD, MHSA; Demetris Yannopoulos, MD; Scott McKnite, BA; Chris von Briesen, BA, EMT; Christopher W. Sparks, EMT; Craig J. Conrad, RN; Terry A. Provo, BA, EMT-P; Keith G. Lurie

TABLE 2. Animal Protocol I: Changes in Hemodynamics and Arterial Blood Gases With Three Different Ventilation Rates Delivered in Random Order (Mean±SEM)

<table>
<thead>
<tr>
<th>Ventilation Rate, Breaths per Minute</th>
<th>12</th>
<th>20</th>
<th>30</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hemodynamics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAP, mm Hg</td>
<td>68.8±4.7</td>
<td>62.7±4.2</td>
<td>60.1±3.6</td>
<td>0.33</td>
</tr>
<tr>
<td>CPP, mm Hg</td>
<td>23.4±1.0</td>
<td>19.5±1.8</td>
<td>16.9±1.8</td>
<td>0.03</td>
</tr>
<tr>
<td>MIP, mm Hg per minute</td>
<td>7.1±0.7</td>
<td>11.6±0.7</td>
<td>17.5±1.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Arterial blood gases</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.34±0.02</td>
<td>7.45±0.03</td>
<td>7.52±0.03</td>
<td>0.0006</td>
</tr>
<tr>
<td>PacO2, mm Hg</td>
<td>22.7±2.7</td>
<td>15.6±2.2</td>
<td>11.6±1.5</td>
<td>0.005</td>
</tr>
<tr>
<td>PacO2, mm Hg</td>
<td>340.9±40.7</td>
<td>403.3±47.0</td>
<td>403.7±48.0</td>
<td>0.59</td>
</tr>
</tbody>
</table>

SAP, Systolic aortic pressure; CPP, coronary perfusion pressure; MIP, mean intrathoracic pressure.

Statistical analysis was done by ANOVA. A value of \(P<0.05\) was considered statistically significant.

MMH/EMA

Figure 3. Survival Study (n=7 pigs per group). Changes in mean intrathoracic pressure (MIP), arterial CO2 (Paco2), coronary perfusion pressure (CPP), and survival rate, with hyperventilation and correction of hypocapnia (+CO2). Probability value of \(<0.05\) was considered statistically significant, based on ANOVA analysis of the 3 groups.
Advanced Cardiac Arrest

Comparative Effectiveness of Standard CPR versus Active Compression Decompression CPR with Augmentation of Negative Intrathoracic Pressure for Treatment of Out-of-Hospital Cardiac Arrest: Results from a Randomized Prospective Study

Tom P. Aufderheide, M.D.

Figure 3.
Age Distribution of Patients Surviving to Hospital Discharge with a Favorable Neurologic Function. Results are shown as percent of patients/age group. Favorable Neurologic function was defined as MRS ≤ 3.
Advanced Cardiac Arrest

- Ventilation Port
- Ventilation Timing Assist Lights: provide guidance to the rescuer on proper ventilation rate to optimize cardiac output and oxygenation.
- Ventilation Guidance Switch: slide for use of the ventilation timing assist lights.
- Atmospheric Pressure Sensor System: augments blood flow to the heart when intrathoracic pressures are < 0 ATMs.
- Single Use Only
- Resistance Regulator: enables inspiration if spontaneous respiration resumes.
- Patient Port: allows fast and easy connection to an endotracheal tube or other airway adjuncts.
Figure 5.
Cumulative Rates of Achieving the Primary Endpoint (mRS ≤3 at Hospital Discharge). Results are shown for pivotal phase enrollment (N=1653) by quarter. Consistent results in both groups were demonstrated throughout the entire duration of the study. Enrollment in Site 6 was initiated in the 4th Quarter (Q) of 2007 and in Site 7 in the 1st Quarter of 2009.
Advanced Cardiac Arrest

Use a ventilator?

• RR = 6 - 8
• VC – 400 - 500
• 100% FIO2 until ROSC
• Set Pressure alarm to 100
• Flow rate = 30 lpm

emcrit
CIRCULATION
A Simplified and Structured Teaching Tool for the Evaluation and Management of Pulseless Electrical Activity

Laszlo Littmann\textsuperscript{a}  Devin J. Bustin\textsuperscript{b}  Michael W. Haley\textsuperscript{a, c}

Departments of \textsuperscript{a}Internal Medicine and \textsuperscript{b}Emergency Medicine, and \textsuperscript{c}Pulmonary and Critical Care Consultants, Carolinas Medical Center, Charlotte, N.C., USA
Fig. 1. Causes of PEA listed by European and American guidelines. Hypoglycemia and trauma have been removed from the most recent ACLS guidelines [6, 7]. PTX = Pneumothorax.

Fig. 2. New classification of PEA based on its initial electrocardiographic manifestation. LV = Left ventricular; PTX = pneumothorax; US = ultrasound; RV = right ventricular.
Fig. 3. Treatment recommendations for narrow-complex PEA. PTX = Pneumothorax. RV = right ventricular.

Fig. 4. Treatment recommendations for wide-complex PEA. IV = Intravenous; LV = left ventricular.
Clinical paper

Estimating the impact of off-balancing forces upon cardiopulmonary resuscitation during ambulance transport

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\textsuperscript{b} School of Medicine, Virginia Commonwealth University, Richmond, VA, United States

M.C. Kurz et al. / Resuscitation 83 (2012) 1085–1089

**Predicted Effect of Jerk Vectors on CPR and CPP**

Fig. 2. Impact of Jerk vectors upon CPR and CPP utilizing the theoretical model.
Quality of cardiopulmonary resuscitation before and during transport in out-of-hospital cardiac arrest

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Received 30 March 2007; received in revised form 1 July 2007; accepted 7 July 2007

Key words
Advanced life support (ALS);
Cardiac arrest;
Chest compression;
Ambulance;
Out-of-hospital CPR;
Outcome;
Transthoracic impedance;
Transport

Summary
Aim of the study: To evaluate quality of cardiopulmonary resuscitation (CPR) performed during transport after out-of-hospital cardiac arrest.

Materials and methods: Retrospective, observational study of all non-traumatic cardiac arrest patients older than 18 years who received CPR both before and during transport between May 2003 and December 2006 from the community run EMS system in Oslo. Chest compressions and ventilations were detected from impedance changes in routinely collected ECG signals, and hands-off ratio calculated as time without chest compressions divided by total CPR time.

Results: Seventy-five of 787 consecutive out-of-hospital cardiac arrest patients met the inclusion criteria. Quality data were available from 36 of 66 patients receiving manual CPR and 7 of 9 receiving mechanical CPR. CPR was performed for mean 21 ± 11 min before and 12 ± 8 min during transport. With manual CPR hands-off ratio increased from 0.19 ± 0.09 on-scene to 0.27 ± 0.15 (p = 0.002) during transport. Compression and ventilation rates were unchanged causing a reduction in compressions per minute from 94 ± 14 min⁻¹ to 82 ± 19 min⁻¹ (p = 0.001). Quality was significantly better with mechanical than manual CPR. Four patients (5%) survived to hospital discharge: two with manual CPR (Cerebral performance categories (CPC) 1 and 5).
Video-recording and time-motion analyses of manual versus mechanical cardiopulmonary resuscitation during ambulance transport.

Figure 5: Causes of time lag from ambulance loading to first chest compression in the manual group.
**Muscles Used for Chest Compression Under Static and Transportation Conditions**

Yasuharu Yasuda, PhD, EMT-P, Yoshinori Kato, EMT-P, Katsuhiko Sugimoto, PhD, MD, Shigeharu Tanaka, MS, Naoya Tsunoda, PhD, Daisuke Kumagawa, PhD, Yoshiki Toyokuni, MS, Katsuaki Kubota, PhD, Hideo Inaba, PhD, MD
Advanced Cardiac Arrest
Advanced Cardiac Arrest

Figure 2: Meta-analysis of the outcomes survived event and survival to hospital discharge or 30 days
(A) Survival to discharge or 30 days. (B) Survived event. (C) Survival with CPC 1-2.
Mechanical CPR = Good Manual CPR

... when not in a moving ambulance
AHA Consensus Statement

Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital

A Consensus Statement From the American Heart Association

Endorsed by the American College of Emergency Physicians and the Society of Critical Care Medicine

Peter A. Meaney, MD, MPH, Chair; Bentley J. Bobrow, MD, FAHA, Co-Chair;
Mary E. Mancini, RN, PhD, NE-BC, FAHA; Jim Christenson, MD; Allan R. de Caen, MD;
Farhan Bhanji, MD, MSc, FAHA; Benjamin S. Abella, MD, MPhil, FAHA;
Monica E. Kleinman, MD; Dana P. Edelson, MD, MS, FAHA; Robert A. Berg, MD, FAHA;
Tom P. Aufderheide, MD, FAHA; Venu Menon, MD, FAHA; Marion Leary, MSN, RN;
on behalf of the CPR Quality Summit Investigators, the American Heart Association Emergency
Cardiovascular Care Committee, and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation

Abstract—The "2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" increased the focus on methods to ensure that high-quality cardiopulmonary resuscitation (CPR) is
Table 2. Final Recommendations

<table>
<thead>
<tr>
<th>Recommend</th>
<th>Details</th>
</tr>
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</table>
| 1.        | High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built. Target CPR performance metrics include: 
|           | a. CCF >80% |
|           | b. Compression rate of 100–120/min |
|           | c. Compression depth of ≥50 mm in adults with no residual leaning 
|           | i. (At least one third the anterior-posterior dimension of the chest in infants and children) |
|           | d. Avoid excessive ventilation 
|           | i. (Only minimal chest rise and a rate of <12 breaths/min) |
| 2.        | At every cardiac arrest attended by professional rescuers: 
|           | a. Use at least 1 modality of monitoring the team’s CPR performance |
|           | b. Depending on available resources, use at least 1 modality of monitoring the patient’s physiological response to resuscitative efforts |
|           | c. Continually adjust resuscitative efforts based on the patient’s physiological response |
| 3.        | Resuscitation teams should coordinate efforts to optimize CPR during cardiac arrest by: 
|           | a. Starting compressions rapidly and optimizing CPR performance early |
|           | b. Making sure that a team leader oversees the effort and delegates effectively to ensure rapid and optimal CPR performance |
|           | c. Maintaining optimal CPR delivery while integrating advanced care and transport |
| 4.        | Systems of care (EMS system, hospital, and other professional rescuer programs) should: 
|           | a. Determine a coordinated code team response with specific role responsibilities to ensure that high-quality CPR is delivered during the entire event |
|           | b. Capture CPR performance data in every cardiac arrest and use an ongoing CPR CQI program to optimize future resuscitative efforts |
|           | c. Implement strategies for continuous improvement in CPR quality and incorporate education, maintenance of competency, and review of arrest characteristics that include available CPR quality metrics |
| 5.        | A national system for standardized reporting of CPR quality metrics should be developed: 
|           | a. CPR quality metrics should be included and collected in national registries and databases for reviewing, reporting, and conducting research on resuscitation |
|           | b. The AHA, appropriate government agencies, and device manufacturers should develop industry standards for interoperable raw data downloads and reporting from electronic data collected during resuscitation for both quality improvement and research |

AHA indicates American Heart Association; CCF, chest compression fraction; CPR, cardiopulmonary resuscitation; CQI, continuous quality improvement; EMS, emergency medical services.
Further rec’s

- **Invasive Monitoring**
  - CPP > 20 mm Hg

- **Arterial Line Only**
  - Arterial Diastolic Pressure > 25 mm Hg

- **Capnography**
  - ETco2 > 20 mm Hg
  - ROSC = Sustained > 35 - 45

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**Table 1. Compression Pause Requirements for Resuscitation Tasks**

<table>
<thead>
<tr>
<th>Pause Requirement</th>
<th>Task</th>
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<tr>
<td>Generally required</td>
<td>Defibrillation</td>
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<td></td>
<td>Rhythm analysis</td>
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<td>Rotation of compressors</td>
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<td>Backboard placement</td>
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<td></td>
<td>Transition to mechanical CPR or ECMO</td>
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<tr>
<td>Sometimes required</td>
<td>Complicated advanced airway placement in patients who cannot be</td>
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<td></td>
<td>ventilated effectively by bag-valve-mask</td>
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<td></td>
<td>Assessment for return of spontaneous circulation</td>
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<tr>
<td>Generally not required</td>
<td>Application of defibrillator pads</td>
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<td></td>
<td>Uncomplicated advanced airway placement</td>
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<td></td>
<td>IV/O placement</td>
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CPR indicates cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; and IV/O, intravenous/intraosseous.
The need to resume chest compressions immediately after defibrillation attempts: An analysis of post-shock rhythms and duration of pulselessness following out-of-hospital cardiac arrest

Ava E. Pierce*, Lynn P. Roppolo, Pamela Owens, Paul E. Pene, Ahamed H. Idris

The Department of Emergency Medicine, University

Fig. 3. Seconds of asystole (defined in the study as the interval of asystole) after 157 episodes of attempted defibrillation with the frequency that each interval of asystole occurred in this study. Twenty-five episodes of defibrillation had intervals of asystole between 128 and 1098 s (not depicted on the chart).
Adverse Hemodynamic Effects of Interrupting Chest Compressions for Rescue Breathing During Cardiopulmonary Resuscitation for Ventricular Fibrillation Cardiac Arrest

Robert A. Berg, MD; Arthur B. Sanders, MD; Karl B. Kern, MD; Ronald W. Hilwig, DVM, PhD; Joseph W. Heidenreich, BA; Matthew E. Porter, BA; Gordon A. Ewy, MD

Background—Despite improving arterial oxygen saturation and pH, bystander cardiopulmonary resuscitation (CPR) with chest compressions plus rescue breathing (CC+RB) has not improved survival from ventricular fibrillation (VF) compared with chest compressions alone (CC) in numerous animal models and 2 clinical investigations.

Methods and Results—After 3 minutes of untreated VF, 14 swine (32±1 kg) were randomly assigned to receive CC+RB or CC for 12 minutes, followed by advanced cardiac life support. All 14 animals survived 24 hours, 13 with good neurological outcome. For the CC+RB group, the aortic relaxation pressures routinely decreased during the 2 rescue breaths. Therefore, the mean coronary perfusion pressure of the first 2 compressions in each compression cycle was lower than those of the final 2 compressions (14±1 versus 21±2 mm Hg, P<0.001). During each minute of CPR, the number of chest compressions was also lower in the CC+RB group (82±1 versus 92±1 compressions, P<0.001). Consequently, the integrated coronary perfusion pressure was lower with CC+RB during each minute of CPR (P<0.05 for the first 8 minutes). Moreover, at 2 to 5 minutes of CPR, the median left ventricular blood flow by fluorescent microsphere technique was 60 mL·100 g⁻¹·min⁻¹ with CC+RB versus 96 mL·100 g⁻¹·min⁻¹ with CC, P<0.05. Because the arterial oxygen saturation was higher with CC+RB, the left ventricular myocardial oxygen delivery did not differ.

Conclusions—Interrupting chest compressions for rescue breathing can adversely affect hemodynamics during CPR for VF. (Circulation. 2001;104:2465-2470.)

Key Words: cardiopulmonary resuscitation ■ heart arrest ■ hemodynamics ■ fibrillation ■ ventilation
Coronary Perfusion is Dependent on Active CPR

Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest

Ahamed H. Idris, MD; Danielle Guffey, MS; Paul P. Pepe, MD; Siobhan P. Brown, PhD; Steven C. Brooks, MD; Clifton W. Callaway, MD, PhD; Jim Christenson, MD; Daniel P. Davis, MD; Mohamud R. Daya, MD; Randal Gray, BS, MA Ed, NREMT-P; Peter J. Kuderchuk, MD; Jonathan Larsen, EMT-P; Steve Lin, MD; James J. Menegazzi, PhD; Kellie Sheehan, BSN; George Sopko, MD, MPH; Ian Stiell, MD, MSc; Graham Nichol, MD; Tom P. Aufderheide, MD; for The Resuscitation Outcomes Consortium Investigators

rates between 100 and 120/min during cardiopulmonary resuscitation for out-of-hospital cardiac arrest. However, the relationship between compression rate and survival is still undetermined.

Design: Prospective, observational study.

Setting: Data is from the Resuscitation Outcomes Consortium Prehospital Resuscitation Impedance threshold device and Early versus Delayed analysis clinical trial.

Participants: Adults with out-of-hospital cardiac arrest treated by emergency medical service providers.

Interventions: None.

Measurements/Results: Data were abstracted from monitor-defibrillator recordings for the first five minutes of emergency medical service cardiopulmonary resuscitation. Multiple logistic regression assessed odds ratio for survival by compression rate categories (≤50, 50–99, 100–119, 120–139, ≥140), both unadjusted and adjusted for sex, age, witnessed status, attempted bystander cardiopulmonary resuscitation, location of arrest, chest compression fraction and depth, first rhythm, and study site. Compression rate data were available for 10,071 patients; 6,000 also had chest compression fraction and depth data. Age (mean ± SD) was 67 ± 16 years. Chest compression rate was 111 ± 19 per minute, compression fraction was 0.70 ± 0.17, and compression depth was 42 ± 12 mm. Circulation was restored in 34%; 9% survived to hospital discharge. After adjustment for covariates without chest compression depth and fraction (n = 10,371), a global test found no significant relationship between compression rate and survival (p = 0.19). However, after adjustment for covariates including chest compression depth and fraction (n = 6,000), the global test found a significant relationship between compression rate and survival (p = 0.02), with the reference group (100–119 compressions/min) having the greatest likelihood for survival.

Conclusions: After adjustment for chest compression fraction and depth, compression rates between 100 and 120 per minute were associated with greatest survival to hospital discharge. (Crit Care Med 2014; XX:00–00)

Key Words: cardiac arrest; cardiopulmonary resuscitation; compression rate; guidelines; heart arrest; outcomes
Adverse Outcomes of Interrupted Precordial Compression During Automated Defibrillation

Ting Yu, MD; Max Harry Weil, MD, PhD; Wanchun Tang, MD; Shijie Sun, MD; Kada Klouche, MD; Henior Povoas, MD; Joe Bisera, MSEE

Background—Current versions of automated external defibrillators (AEDs) require frequent stopping of chest compression for rhythm analyses and capacity charging. The present study was undertaken to evaluate the effects of these interruptions during the operation of AEDs.

Methods and Results—Ventricular fibrillation was electrically induced in 20 male domestic swine weighing between 37.5 and 43 kg that were untreated for 7 minutes before CPR was started. Defibrillation was attempted with up to 3 sequential 150-J biphasic shocks, but each was preceded by 3-, 10-, 15-, or 20-second interruptions of chest compression. The interruptions corresponded to those that were mandated by commercially marketed AEDs for rhythm analyses and capacitor charge. The sequence of up to 3 electrical shocks and delays were repeated at 1-minute intervals until the animals were successfully resuscitated or for a total of 15 minutes. Spontaneous circulation was restored in each of 5 animals in which precardial compression was delayed for 3 seconds before the delivery of the first and subsequent shocks but in none of the animals in which the delay was >15 seconds before the delivery of the first and subsequent shocks. Longer intervals of CPR interventions were required, and there was correspondingly greater failure of resuscitation in close relationship to increasing delays. The durations of interruptions were inversely related to the durations of subthreshold levels of coronary perfusion pressure. Postresuscitation arterial pressure and left ventricular ejection fraction were more severely impaired with increasing delays.

Conclusions—Interruptions of precardial compression for rhythm analyses that exceed 15 seconds before each shock compromise the outcome of CPR and increase the severity of postresuscitation myocardial dysfunction. (Circulation. 2002;106;368-372.)

Key Words: cardiopulmonary resuscitation  ■  fibrillation  ■  defibrillation  ■  compression  ■  myocardium
Clinical Investigation

Coronary Perfusion Pressure and the Return of Spontaneous Circulation in Human Cardiopulmonary Resuscitation

Norman A. Paradis, MD; Gerard B. Martin, MD; Emanuel P. Rivers, MD; Mark G. Goetling, MD; Timothy J. Appleton; Marcia Feingold, PhD; Richard M. Hornick, MD

Figure 2. Survival from prolonged cardiac arrest in canines relates to coronary perfusion pressure generated during external chest compressions. See text.
Resuscitation Science Symposium

Abstract P115: Higher Threshold and Dose of Coronary Perfusion Pressure are Associated with ROSC in Prolonged Swine Cardiac Arrest

Joshua C Reynolds; David D Salcido; James J Menegazzi

Univ of Pittsburgh, Pittsburgh, PA
Hemodynamic–directed cardiopulmonary resuscitation during in-hospital cardiac arrest

Robert M. Sutton\textsuperscript{a}, Stuart H. Friess\textsuperscript{b}, Matthew R. Maltese\textsuperscript{a}, Maryam Y. Naim\textsuperscript{a}, George Bratnov\textsuperscript{a}, Theodore R. Weiland\textsuperscript{a}, Mia Garuccio\textsuperscript{a}, Utpal Bhalala\textsuperscript{c}, Vinay M. Nadkarni\textsuperscript{a}, Lance B. Becker\textsuperscript{d}, and Robert A. Berga\textsuperscript{a,*}

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Advanced Cardiac Arrest

Fig. 1.
Mean coronary perfusion pressure during each minute of CPR between survivors after hypoxic ventricular fibrillation. Similar results were also obtained in the VF model. Error bars represent SEM. Modified from Sutton et al.7 R

Fig. 2.
Percentage of patients achieving return of spontaneous circulation (ROSC) during adult cardiac arrest resuscitation. Modified from Paradis et al.,12 Journal of the American Medical Association 1990.
Figure 1. Identifying a common point on pressure waveforms: the “end-diastolic” method

Experimental paper

Hemodynamic directed CPR improves cerebral perfusion pressure and brain tissue oxygenation

Stuart H. Friess, Robert M. Sutton, Benjamin French, Utpal Bhalala, Matthew R. Maltese, Maryam Y. Naim, Georg Silvana Arciniegas Rodriguez, Theodore R. We Vinay M. Nadkarni, Lance B. Becker, Robert A

ABSTRACT

Aim: Advances in cardiopulmonary resuscitation (CPR) have focused on the generation and maintenance of adequate myocardial blood flow to optimize the return of spontaneous circulation and survival. Much of the morbidity associated with cardiac arrest survivors can be attributed to global brain hypoxic ischemic injury. The objective of this study was to compare cerebral physiological variables using a hemodynamic directed resuscitation strategy versus an absolute depth-guided approach in a porcine model of ventricular fibrillation (VF) cardiac arrest.

Methods: Intracranial pressure and brain tissue oxygen tension probes were placed in the frontal cortex prior to induction of VF in 21 female 3-month-old swine. After 7 min of VF, animals were randomized to receive one of three resuscitation strategies: (1) hemodynamic directed care (CPP-20): chest compressions (CCs) with depth titrated to a target systolic blood pressure of 100 mmHg and titration of vasopressors to maintain coronary perfusion pressure (CPP) >20 mmHg; (2) depth 33 mm (D33): target CC depth of 33 mm with standard American Heart Association (AHA) epinephrine dosing; or (3) depth 51 mm (D51): target CC depth of 51 mm with standard AHA epinephrine dosing.

Results: Cerebral perfusion pressures (CerePP) were significantly higher in the CPP-20 group compared to both D33 (p < 0.01) and D51 (p = 0.046), and higher in survivors compared to non-survivors irrespective of treatment group (p < 0.01). Brain tissue oxygen tension was also higher in the CPP-20 group compared to both D33 (p = 0.01) and D51 (p = 0.013), and higher in survivors compared to non-survivors irrespective of treatment group (p < 0.01). Subjects with a CPP >20 mmHg were 2.7 times more likely to have a CerePP >10 mmHg (p < 0.001).

Conclusions: Hemodynamic directed resuscitation strategy targeting coronary perfusion pressure >20 mmHg following VF arrest was associated with higher cerebral perfusion pressures and brain tissue oxygen tensions during CPR.
Arterial Blood Pressure and Neurologic Outcome After Resuscitation From Cardiac Arrest

J. Hope Kilgannon, MD; Brian W. Roberts, MD; Alan E. Jones, MD; Neil Mittal, MD; Evan Cohen, MD; Jessica Mitchell, MD; Michael E. Chansky, MD; Stephen Trzeciak, MD, MPH

Objectives: Guidelines for post-cardiac arrest care recommend blood pressure optimization as one component of neuroprotection. Although some retrospective clinical studies suggest that postresuscitation hypertension may be harmful, and laboratory studies suggest that a postresuscitation hypertensive surge may be protective, empirical data are rare. In this study, we prospectively measured blood pressure over time during the postresuscitation period and tested its association with neurologic outcomes.


Patients: Inclusion criteria were age 18 years old or older, pre-arrest independent functional status, resuscitation from cardiac arrest, and consciousness immediately after resuscitation.

Measurements and Main Results: Our research protocol measured blood pressure noninvasively every 15 minutes for the first 6 hours after resuscitation. We calculated the 0- to 6-hour time-weighted average mean arterial pressure and used nonparametric logistic regression to test the association between time-weighted average mean arterial pressure and outcomes, defined as Glasgow Coma Scale score of 3 or 2 at hospital discharge. Among 1,133 incidentally normal neurologic outcome blood pressure and outcome after post-cardiac arrest syndrome is a state of severe, global ischemia/reactivation injury with potentially

Patient-Centric Blood Pressure-targeted Cardiopulmonary Resuscitation Improves Survival from Cardiac Arrest


1Department of Anesthesiology and Critical Care Medicine, The Children’s Hospital of Philadelphia, and 2Department of Emergency Medicine, The Hospital of the University of Pennsylvania, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania; and 3Department of Pediatrics, St. Louis Children’s Hospital, Washington University in St. Louis School of Medicine, St. Louis, Missouri
Cardiocerebral Resuscitation Improves Neurologically Intact Survival of Patients With Out-of-Hospital Cardiac Arrest

Michael J. Kellum, MD
Kevin W. Kennedy, MS
Richard Barney, MD
Franz A. Keilhauer, MD
Michael Bellino, MD
Mathias Zuerncher, MD
Gordon A. Ewy, MD

From the Departments of Emergency Medicine at Mercy Health System, Janesville, WI (Kellum, Kennedy, Keilhauer); Beloit Memorial Hospital, Beloit, WI (Barney); Aurora Lakeland Medical Center, Elkhorn, WI (Bellino); University of Arizona Sarver Heart Center, University of Arizona College of Medicine, Tucson, AZ (Zuercher, Ewy); and University of Basel, Basel, Switzerland (Zuercher).

Study objective: In an effort to improve neurologically normal survival of victims of cardiac arrest, a new out-of-hospital protocol was implemented by the emergency medical system medical directors in 2 south-central rural Wisconsin counties. The project was undertaken because the existing guidelines for care of such patients, despite their international scope and periodic updates, had not substantially improved survival rates for such patients during nearly 4 decades.

Methods: The neurologic status at or shortly after discharge was documented for adult patients with a witnessed collapse and an initial shockable rhythm. Patients during two 3-year periods were compared. During the 2001 through 2003 period, in which the 2000 American Heart Association guidelines were used, data were collected retrospectively. During the mid-2004 through mid-2007 period, patients were treated according to the principles of cardiocerebral resuscitation. Data for these patients were collected prospectively. Cerebral performance category scores were used to define the neurologic status of survivors, and a score of 1 was considered as “intact” survival.

Results: In the 3 years preceding the change in protocol, there were 92 witnessed arrests with an initially shockable rhythm. Eighteen patients survived (20%) and 14 (15%) were neurologically intact. During the 3 years after implementation of the new protocol, there were 89 such patients. Forty-two (47%) survived and 35 (39%) were neurologically intact.

Conclusion: In adult patients with a witnessed cardiac arrest and an initially shockable rhythm, implementation of an out-of-hospital treatment protocol based on the principles of cardiocerebral resuscitation was associated with a dramatic improvement in neurologically intact survival. [Ann Emerg Med. 2008;52:244-252.]
Cardiocerebral Resuscitation: An Approach to Improving Survival of Patients With Primary Cardiac Arrest

Gordon A. Ewy MD1 and Bentley J. Bobrow, MD2,3

Journal of Intensive Care Medicine
1-10

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DOI: 10.1177/0885066614544450
Advanced Cardiac Arrest

(aka Minimally Interrupted Cardiac Resuscitation)

EMS ARRIVAL

- EMD: pre-arrival CO-CPR instructions
- Single shock if indicated without pulse check or rhythm analysis
- Single shock if indicated without pulse check or rhythm analysis
- Single shock if indicated without pulse check or rhythm analysis
- Transport to closest CRC if possible

Bystander CO-CPR

Chest Compressions:
- 100/min
- at least 2” in depth
- full chest recoil

200 chest compressions

Analysis

200 chest compressions

Analysis

200 chest compressions

Analysis

200 chest compressions

Administer 1 mg IV/IO Epinephrine

Resume standard ACLS (30:2)

Consider ETI
(Do NOT interrupt Compressions)

*If adequate uninterrupted bystander chest compressions are provided, EMS providers perform immediate rhythm analysis.

CO-CPR = compression-only CPR
CRC = cardiac receiving center
EMD = emergency medical dispatch

MMH/EMA
Figure 1. Simultaneous recording of aortic and right atrial pressures during first 15 external chest compressions in swine in cardiac arrest due to ventricular fibrillation. AoS indicates aortic “systolic” pressure during chest compression; AoD, aortic “diastolic” pressure during release phase; and RAD, right atrial pressure during “diastolic” or release phase of chest compression.

Figure 3. Simultaneous recording of aortic and right atrial pressures during continuous external chest compressions in swine in cardiac arrest due to ventricular fibrillation. AoS indicates aortic “systolic” pressure during chest compression; AoD, aortic “diastolic” pressure during release phase; and RAD, right atrial pressure during “diastolic” or release phase of chest compression.
Precountershock Cardiopulmonary Resuscitation Improves Ventricular Fibrillation Median Frequency and Myocardial Readiness for Successful Defibrillation From Prolonged Ventricular Fibrillation: A Randomized, Controlled Swine Study

Robert Allen Berg, MD
Donald Willard Wilbur, MD

See related article, p. 553, and editorial, p. 571.
The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial


ABSTRACT

Background: Previous research has demonstrated significant relationships between peri-shock pause and survival to discharge from out-of-hospital shockable cardiac arrest (OHCA).

Objective: To determine the impact of peri-shock pause on survival from OHCA during the ROC PRIMED randomized controlled trial.

Methods: We included patients in the ROC PRIMED trial who suffered OHCA between June 2007 and November 2009, presented with a shockable rhythm and had CPR process data for at least one shock. We used multivariable logistic regression to determine the association between peri-shock pause duration and survival to hospital discharge.

Results: Among 2006 patients studied, the median (IQR) shock pause duration was: pre-shock pause 15 s (8, 22); post-shock pause 6 s (4, 9); and peri-shock pause 22.0 s (14, 31). After adjusting for Utstein predictors of survival as well as CPR quality measures, the odds of survival to hospital discharge were significantly higher for patients with pre-shock pause <10 s (OR: 1.52, 95% CI: 1.09, 2.11) and peri-shock pause <20 s (OR: 1.82, 95% CI: 1.17, 2.85) when compared to patients with pre-shock pause ≥20 s and peri-shock pause ≥40 s. Post-shock pause was not significantly associated with survival to hospital discharge. Results for neurologically intact survival (Modified Rankin Score ≤3) were similar to our primary outcome.

Conclusions: In patients with cardiac arrest presenting in a shockable rhythm during the ROC PRIMED trial, shorter pre- and peri-shock pauses were significantly associated with higher odds of survival. Future cardiopulmonary education and technology should focus on minimizing all peri-shock pauses.

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Fig. 2. Plot of unadjusted survival to hospital discharge versus median shock pause interval. Survival results are shown as column plots referring to the left-side axis, categorized into 5 shock pause interval ranges, and stratified by pre-shock and post-shock pause classification. Counts of available cases for each survival estimate are shown for each shock pause interval range as line plots referring to the right-side axis.
Brief Report

Defibrillator charging before rhythm analysis significantly reduces hands-off time during resuscitation: a simulation study

Lars Koch Hansen MD, Lars Folkestad MD, Mikkel Brabrand MD

ERC 2005

ERC 2010

Alternative Sequence

CPR

Rhythm analysis

Charging of defibrillator

Shock delivery

Hands-off time
Simulation and education

Rhythm analysis and charging during chest compressions reduces compression pause time

R. Partridge, Q. Tan, A. Silver, M. Riley, F. Geheb, R. Raymond

Fig. 4. For both shockable and non-shockable rhythm intervals, chest compression interruptions were significantly shorter with ADC-FR vs. AED defibrillator operation.

Fig. 5. Shockable rhythms: pre-shock pause was significantly shortened during intervals with ADC-FR compared with AED whereas post-shock pause was unchanged.
Advanced Cardiac Life Support in Out-of-Hospital Cardiac Arrest


ABSTRACT

BACKGROUND

The Ontario Prehospital Advanced Life Support (OPALS) Study tested the incremental benefit of...
CONCLUSIONS
The addition of interventions did not improve survival after out-of-hospital cardiac arrest, even when optimized emergency medical services systems were used. Health care providers should make cardiopulmonary resuscitation by emergency medical services a priority for these patients.
CONCLUSIONS AND RELEVANCE

ALS and were less likely to experience poor neurological functioning. Cardiac arrest who received BLS had higher survival at hospital discharge after 30 days compared with those who received advanced cardiac arrest.
Prehospital Cardiac Arrest: Out-of-Hospital Cardiac Arrest (OHCA) is a medical emergency that requires immediate intervention to save lives. OHCA is a life-threatening condition that occurs when the heart stops beating, causing the body to lack oxygen. It is crucial to respond quickly to provide CPR and stabilize the patient to improve outcomes.

Epinephrine is widely used in cardiopulmonary resuscitation (CPR) and is considered a standard therapy for out-of-hospital cardiac arrest (OHCA). However, the effectiveness of epinephrine in improving long-term outcomes has not been well established.

To investigate the association between epinephrine use before hospital arrival and long-term mortality in patients with cardiac arrest, a retrospective study was conducted.

### Participants
Prospective, nonrandomized, observational study of 188,000 OHCA patients in Japan over a period of 5 years. Patients were divided into two groups: epinephrine users and non-users. Patients who received epinephrine before hospital arrival were compared with those who did not.

### Main Findings
- Spontaneous circulation before hospital arrival was observed in 15,030 patients (18.5%).
- Survival with return of spontaneous circulation before hospital arrival was associated with survival with good or moderate cerebral performance category (CPC 1 or 2), and survival with CPC 1-2, respectively.

### Results
- In the epinephrine group (n=13,401), survival with return of spontaneous circulation before hospital arrival was observed in 15,030 patients (18.5%).
- In the non-epinephrine group (n=13,401), survival with return of spontaneous circulation before hospital arrival was observed in 12,430 patients (18.0%).

### Conclusions
- Among patients with OHCA in Japan, use of prehospital epinephrine was significantly associated with increased chance of return of spontaneous circulation before hospital arrival but decreased chance of survival and good functional outcome.

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MMH/EMA
Clinical payment

Effectiveness of early adrenaline (epinephrine) for out-of-hospital cardiac arrest: A randomized trial

Harry F. Oxer, Peter L. Thompson

University of Western Australia, Australia

Abstract

Background: There is little evidence about the effectiveness of adrenaline (epinephrine) for out-of-hospital cardiac arrest.

The aim of our study was to determine if early adrenaline improves survival from out-of-hospital cardiac arrest.

Methods: We conducted a double-blind, randomized controlled trial of 4173 cardiac arrests. Patients were randomized to receive adrenaline (0.9%) or placebo (0.9%). The primary outcome was survival to hospital discharge.

Results: A total of 4173 cardiac arrests were screened during the study period. Early adrenaline was given in 22% of cases, compared to 25% in the placebo group. The primary outcome of survival to hospital discharge was significantly higher in the adrenaline group compared to the placebo group (29.4% vs. 24.0%, P=0.01).

Conclusion: Early adrenaline improves survival from out-of-hospital cardiac arrest.
Advanced Cardiac Arrest
Prehospital Epinephrine Use and Survival Among Patients With Out-of-Hospital Cardiac Arrest

Akihito Hagiwara, DMSc, MPH
Manabu Hasegawa, MD
Takanori Abo, MA
Takashi Nagata, MD
Yoshifumi Wakata, MD
Shogo Miyazaki, PhD

Epinephrine is widely used in cardiopulmonary resuscitation (CPR) for patients with out-of-hospital cardiac arrest (OHCA). However, its effectiveness in CPR has not been established. Epinephrine is associated with increased myocardial oxygen consumption and ventricular arrhythmias during the period after resuscitation. Concern has been raised regarding increased myocardial dysfunction and disturbed cerebral microcirculation after cardiac arrest. Findings in support of epinephrine use include animal studies that show a beneficial short-term effect of epinephrine and evidence of increased cerebral and coronary perfusion by redirected peripheral blood flow has been reported.

To verify the effectiveness of epinephrine in CPR, the influences of other factors, such as patients, bystanders, CPR by bystanders, life support by emergency medical service (EMS) personnel, and time from call to the scene or hospital arrival, need to be controlled. To control for the effects of co-
Intravenous Access and Drug Administration During Out-of-Hospital Cardiac Arrest

A Randomized Controlled Trial

Objective: Intravenous access and drug administration are included in Advanced Cardiac Life Support (ACLS) guidelines despite a lack of evidence for improved outcome. The main objective of this trial was to evaluate whether establishing an intravenous line and drug administration after out-of-hospital cardiac arrest affects survival to hospital discharge after out-of-hospital cardiac arrest.

Methods: This was a randomized controlled trial of consecutive adult patients on whom an in-hospital cardiac arrest treated within the emergency medical service resuscitation. Patients were randomized to the intervention group (intravenous access and drug administration) or control group (no intravenous access). The primary outcome was survival to hospital discharge after out-of-hospital cardiac arrest.

Results: Of 1183 patients for whom resuscitation was attempted, 418 patients were in the ACLS with intravenous drug administration group and 765 patients in the ACLS with no access to intravenous drug administration group. The difference in survival to hospital discharge was 10.6% (95% CI: -2.7% to 23.9%) (P = .053).

Conclusions: This study did not find a statistically significant difference in survival to hospital discharge between the two groups.
Other drugs:
There is no convincing evidence that the routine use of other drugs (atropine, amiodarone, lidocaine, procainamide, bretylium, magnesium, buffers, calcium, hormones or fibrinolytics) during human CPR increases survival to hospital discharge.4

Vasopressors:
Despite the continued widespread use of adrenaline and increased use of vasopressin during resuscitation in some countries, there is no placebo-controlled study that shows that the routine use of any vasopressor during human cardiac arrest increases survival to hospital discharge.4 Although there is evidence that vasopressors (adrenaline or vasopressin) may improve return of spontaneous circulation and short-term survival, there is insufficient evidence to suggest that vasopressors improve survival to discharge and neurologic outcome. There is insufficient evidence to suggest the optimal dosage of any vasopressor in the treatment of adult cardiac arrest. Given the observed benefit in short-term outcomes, the use of adrenaline or vasopressin may be considered in adult cardiac arrest.4 [Class A, Expert consensus opinion]
Impact of Early Intravenous Epinephrine Administration on Outcomes Following Out-of-Hospital Cardiac Arrest

Yasuyuki Hayashi, MD, PhD; Taku Iwami, MD, PhD; Tetsuhsa Kitamura, MD; Tatsuya Nishiuchi, MD, PhD; Kentaro Kajino, MD, PhD; Tomohiko Sakai, MD, PhD; Chika Nishiyama, PhD; Masahiko Nitta, MD, PhD; Atsushi Hiraide, MD, PhD; Tatsuro Kai, MD

**Background:** The effectiveness of epinephrine administration for cardiac arrests has been shown in animal models, but the clinical effect is still controversial.

**Methods and Results:** A prospective, population-based, observational study in Osaka involved consecutive out-of-hospital cardiac arrest (OHCA) patients from January 2007 through December 2009. We evaluated the outcomes among adult non-traumatic bystander-witnessed OHCA patients for whom the local protocol directed the emergency medical service personnel to administer epinephrine. After stratifying by first documented cardiac rhythm, outcomes were compared among the following groups: non-administration, ≤10, 11–20 and ≥21 min as the time from emergency call to epinephrine administration. A total of 3,161 patients were eligible for our analyses, among whom 1,013 (32.0%) actually received epinephrine. The epinephrine group had a significantly lower rate of neurologically intact 1-month survival than the non-epinephrine group (4.1% vs. 6.1%, P=0.028). In cases of ventricular fibrillation (VF) arrest, patients in the early epinephrine group who received epinephrine administration within 10 min had a significantly higher rate of neurologically intact 1-month survival compared with the non-epinephrine group (66.7% vs. 24.9%), though other epinephrine groups did not. In cases of non-VF arrest, the rate of neurologically intact 1-month survival was low, irrespective of epinephrine administration.

**Conclusions:** The effectiveness of epinephrine after OHCA depends on the time of administration. When epinephrine is administered in the early phase, there is an improvement in neurological outcome from OHCA with VF. (Circ J 2012; 76: 1639–1645)

**Key Words:** Cardiac arrest; Cardiopulmonary resuscitation; Epidemiology; Epinephrine; Sudden death
Volume versus outcome: More emergency medical services personnel on-scene and increased survival after out-of-hospital cardiac arrest

Sam A. Warren¹,a,b,⁎, David K. Prince⁴,d,g, Ella Huszti¹,a,b, Tom D. Rea⁴,b, Annette L. Fitzpatrick⁵,c,e,f, Douglas L. Andrusiek⁶, Steve Darling⁷, Laurie J. Morrison¹, Gary M. Vilke⁸, Graham Nichol¹,a,b,g, the ROC Investigators
Prospective use of a clinical decision rule to identify pulmonary embolism as likely cause of outpatient cardiac arrest

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\textsuperscript{b} Department of Emergency Medicine, Carolinas Medical Center, P.O. Box 32861, Charlotte, NC 28223-2861, USA

Received 14 March 2004; received in revised form 27 July 2004; accepted 27 July 2004
1. age <65 years;
2. witnessed arrest (using Utstein criteria);
3. presence of pulseless electrical activity as the first rhythm.

This prospective observational study evaluated a previously derived clinical decision rule designed to identify patients with cardiac arrest who are at high risk for massive PE. This work supported previous findings and resulted in the identification of a population of outpatients with cardiac arrest characterized by PEA, who have a prevalence of PE of greater than 50%. These same patients with PE were more likely to suffer cardiac arrest in the presence of an emergency doctor or paramedic than those identified by the decision rule who did not have PE. The patients with PE also commonly had the triad of respiratory distress, alterations of mental status, and shock prior to arrest.
Fig. 6. The rescuer-received dose is noted at the various measurement points using published rescuer skin resistances for both 5% and 50% population break-down resistances. The horizontal line at 1 J indicates the minimum energy level that is able to cause ventricular fibrillation in a susceptible individual. On the anterior chest wall, where contact would be made with HOD, the energy level is 6–10 times the level needed to cause fibrillation.
Double Sequential External Shocks for Refractory Ventricular Fibrillation

DAVID H. HOCH, MD, PhD, FACC, WILLIAM P. BATSFORD, MD,* STEVEN M. GREENBERG, MD, FACC, CRAIG M. McPHERSON, MD, FACC.* LYNDA E. ROSENFELD, MD, FACC.* MARK MARIEB, MD.* JOSEPH H. LEVINE, MD, FACC
Roslyn, New York and New Haven, Connecticut

Objectives. A technique for terminating refractory ventricular fibrillation is described.

Background. Refractory ventricular fibrillation can occur in up to 0.1% of electrophysiologic studies. Animal studies have shown that rapid sequential shocks may reduce ventricular fibrillation threshold.

Methods. Five patients of 2,990 consecutive patients in a 3-year period experienced refractory ventricular fibrillation during 5,480 routine electrophysiologic studies. Multiple shocks were delivered by means of a single defibrillator. Double sequential shocks were delivered externally 0.5 to 4.5 s apart by means of two defibrillators with separate pairs of electrodes.

Results. In all patients, standard defibrillation was unsuccessful, but all were successfully resuscitated using the double sequential shocks.

Conclusions. This report stresses the importance of an additional defibrillator being readily available during electrophysiologic testing. This technique of rapid, double sequential external shocks may have general applicability, providing a simple and potentially lifesaving approach to refractory ventricular fibrillation.

(J Am Coll Cardiol 1994;23:1141-5)

Cabañas JG, Myers JB, Williams JG, De Maio VJ, Bachman MW.

Abstract
Abstract Background. Ventricular fibrillation (VF) is considered the out-of-hospital cardiac arrest (OOHCA) rhythm with the highest likelihood of neurologically intact survival. Unfortunately, there are occasions when VF does not respond to standard defibrillatory shocks. Current American Heart Association (AHA) guidelines acknowledge that the data are insufficient in determining the optimal pad placement, waveform, or energy level that produce the best conversion rates from OOHCA with VF. Objective. To describe a technique of double sequential external defibrillation (DSED) for cases of refractory VF (RVF) during OOHCA resuscitation. Methods. A retrospective case series was performed in an urban/suburban emergency medical services (EMS) system with advanced life support care and a population of 900,000. Included were all adult OOHCA having RVF during resuscitation efforts by EMS providers. RVF was defined as persistent VF following at least 5 unsuccessful single shocks, epinephrine administration, and a dose of antiarrhythmic medication. Once the patient was in RVF, EMS personnel applied a second set of pads and utilized a second defibrillator for single defibrillation with the new monitor/pad placement. If VF continued, EMS personnel then utilized the original and second monitor/defibrillator charged to maximum energy, and shocks were delivered from both machines simultaneously. Data were collected from electronic dispatch and patient care reports for descriptive analysis. Results. From 01/07/2008 to 12/31/2010, a total of 10 patients were treated with DSED. The median age was 75.5 (IQR: 65-82), with median resuscitation time of 51 minutes (IQR: 45-62). The median number of single shocks was 6.5 (IQR: 6-11), with a median of 2 (IQR: 1-3) DSED shocks delivered. VF broke after DSED in 7 cases (70%). Only 3 patients (30%) had ROSC in the field, and none survived to discharge. Conclusion. This case series demonstrates that DSED may be a feasible technique as part of an aggressive treatment plan for RVF in the out-of-hospital setting. In this series, RVF was terminated 70% of the time, but no patient survived to discharge. Further research is needed to better understand the characteristics of and treatment strategies for RVF.

KEYWORDS: cardiac arrest; defibrillation; double sequential; out-of-hospital; ventricular fibrillation

PMID: 25243771 [PubMed - as supplied by publisher]
Treating Electrical Storm
Sympathetic Blockade Versus Advanced Cardiac Life Support–Guided Therapy

Koonlawee Nademane, MD; Richard Taylor, MD; William E. Bailey, MD; Daniel E. Rieders, MD; Erol M. Kosar, MD

Background—Electrical storm (ES), defined as recurrent multiple ventricular fibrillation (VF) episodes, often occurs in patients with recent myocardial infarction. Because treating ES according to the Advanced Cardiac Life Support (ACLS) guidelines yields a poor outcome, we evaluated the efficacy of sympathetic blockade in treating ES patients and compared their outcome with that of patients treated according to the ACLS guidelines.

Methods and Results—Forty-nine patients (36 men, 13 women, mean age 57±10 years) who had ES associated with a recent myocardial infarction were separated into 2 groups. Patients in group 1 (n=27) received sympathetic blockade treatment: 6 left stellate ganglionic blockade, 7 esmolol, and 14 propranolol. Patients in group 2 (n=22) received antiarrhythmic medication as recommended by the ACLS guidelines. Patient characteristics were similar in the 2 groups. The 1-week mortality rate was higher in group 2: 18 (82%) of the 22 patients died, all of refractory VF; 6 (22%) of the 27 group 1 patients died, 3 of refractory VF (P<0.0001). Patients who survived the initial ES event did well over the 1-year follow-up period: Overall survival in group 1 was 67%, compared with 5% in group 2 (P<0.0001).

Conclusions—Sympathetic blockade is superior to the antiarrhythmic therapy recommended by the ACLS guidelines in treating ES patients. Our study emphasizes the role of increased sympathetic activity in the genesis of ES. Sympathetic blockade—not class 1 antiarrhythmic drugs—should be the treatment of choice for ES. (Circulation. 2000;102:742-747.)
Use of esmolol after failure of standard cardiopulmonary resuscitation to treat patients with refractory ventricular fibrillation

Brian E. Driver\textsuperscript{a,}\textsuperscript{*}, Guillaume Debaty\textsuperscript{a,b,c}, David W. Plummer\textsuperscript{a}, Stephen W. Smith\textsuperscript{a}

\textsuperscript{a} Hennepin County Medical Center, Department of Emergency Medicine, 701 Park Ave S, MC 825, Minneapolis, MN 55415, USA
\textsuperscript{b} University of Minnesota, Department of Medicine-Cardiovascular Division, Mayo Mail Code 508, 420 Delaware Street SE, Minneapolis, MN 55455, USA
\textsuperscript{c} UJF-Grenoble 1/CNRS/CHU de Grenoble/IMCN-UMR 5525, Grenoble, F-38041, France

\begin{abstract}
Introduction: We compare the outcomes for patients who received esmolol during ventricular fibrillation (VF) or ventricular tachycardia (VT) who received at least three defibrillation attempts, 300 mg of amiodarone, and 3 mg of adrenaline, and who remained in CA upon ED arrival. Patients who received esmolol during CA were compared to those who did not.

Methods: A retrospective investigation in an urban academic ED of patients between January 2011 and January 2014 of patients with out-of-hospital or ED cardiac arrest (CA) with an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT) who received at least three defibrillation attempts, 300 mg of amiodarone, and 3 mg of adrenaline, and who remained in CA upon ED arrival. Patients who received esmolol during CA were compared to those who did not.

Results: 90 patients had CA with an initial rhythm of VF or VT; 65 patients were excluded, leaving 25 for analysis. Six patients received esmolol during cardiac arrest, and nineteen did not. All patients had ventricular dysrhythmias refractory to many defibrillation attempts, including defibrillation after administration of standard ACLS medications. Most received high doses of adrenaline, amiodarone, and sodium bicarbonate. Comparing the patients that received esmolol to those that did not: 67% and 42% had temporary return of spontaneous circulation (ROSC); 67% and 32% had sustained ROSC; 66% and 32% survived to intensive care unit admission; 50% and 16% survived to hospital discharge; and 50% and 11% survived to discharge with a favorable neurologic outcome, respectively.

Conclusion: Beta-blockade should be considered in patients with RFV in the ED prior to cessation of resuscitative efforts.
\end{abstract}
END-TIDAL CARBON DIOXIDE AND OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST

ROBERT L. LEVINE, M.D., MARVIN A. WAYNE, M.D., AND CHARLES C. MILLER, PH.D.

**Table 1. End-Tidal Carbon Dioxide Values in Patients Who Survived to Hospital Admission and in Those Who Did Not.**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>NONSURVIVORS (N = 115)</th>
<th>SURVIVORS (N = 35)</th>
<th>P VALUE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>68.0 ± 13.8 (31–95)</td>
<td>71.5 ± 13.0 (27–90)</td>
<td>0.19</td>
</tr>
<tr>
<td>End-tidal carbon dioxide (mm Hg)†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>12.3 ± 6.9 (2–50)</td>
<td>12.2 ± 4.6 (5–22)</td>
<td>0.93</td>
</tr>
<tr>
<td>Final</td>
<td>4.4 ± 2.9 (0–10)</td>
<td>32.8 ± 7.4 (18–58)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*P values were calculated with the Wilcoxon rank-sum statistic.

†Initial end-tidal carbon dioxide levels were determined immediately upon intubation. Final end-tidal carbon dioxide levels were determined after 20 minutes of advanced cardiac life support.

**Figure 1.** Histogram of Number of Patients (Frequency) at Each Value for End-Tidal Carbon Dioxide, with Standard “Midpoint” Groupings.

The majority of the patients were in the group with end-tidal carbon dioxide levels of 10 mm Hg or less, and all these patients died before reaching the hospital. The frequency distribution clearly differentiates between survivors and nonsurvivors. Values are given as standard midpoint groupings for ease of presentation.
1. **End-tidal PCO₂ during cardiopulmonary resuscitation.**
   
   Weil MH, Gazmuri RJ, Kette F, Bisera J, Rackow EC.
   PMID: 2104943
   Similar articles

2. **End-tidal carbon dioxide monitoring during cardiopulmonary resuscitation. A prognostic indicator for survival.**
   
   Sanders AB, Kern KB, Otto CW, Milander MM, Ewy GA.
   JAMA. 1989 Sep 8;262(10):1347-51.
   PMID: 2761035
   Similar articles

3. **End-tidal carbon dioxide monitoring during cardiopulmonary resuscitation.**
   
   Garnett AR, Ornato JP, Gonzalez ER, Johnson EB.
   PMID: 3098993
   Similar articles
Systematic Review and Meta-Analysis of End-Tidal Carbon Dioxide Values Associated With Return of Spontaneous Circulation During Cardiopulmonary Resuscitation.

Hartmann SM, Farris RW, Di Gennaro JL, Roberts JS.

Abstract

OBJECTIVE: End-tidal carbon dioxide (ETCO₂) measurements during cardiopulmonary resuscitation (CPR) reflect variable cardiac output over time, and low values have been associated with decreased survival. The goals of this review are to confirm and quantify this relationship and to determine the mean ETCO₂ value among patients with return of spontaneous circulation (ROSC) as an initial step toward determining an appropriate target for intervention during resuscitation in the absence of prospective data.

DATA SOURCES AND STUDY SELECTION: The PubMed database was searched for the key words "end-tidal carbon dioxide" or "capnometry" or "capnography" and "resuscitation" or "return of spontaneous circulation." Randomized controlled trials, cohort studies, or case-control studies that reported ETCO₂ values for participants with and without ROSC were included.

DATA EXTRACTION AND SYNTHESIS: Twenty-seven studies met the inclusion criteria for qualitative synthesis. Twenty studies were included in determination of average ETCO₂ values. The mean ETCO₂ in participants with ROSC was 25.8 ± 9.8 mm Hg versus 13.1 ± 8.2 mm Hg (P = .001) in those without ROSC. Nineteen studies were included in a meta-analysis. The mean difference in ETCO₂ was 12.7 mm Hg (95% confidence interval: 10.3-15.1) between participants with and without ROSC (P < .001). The mean difference in ETCO₂ was not modified by the receipt of sodium bicarbonate, uncontrolled minute ventilation, or era of resuscitation guidelines. The overall quality of data by Grades of Recommendations, Assessment, Development and Evaluation criteria is very low, but no prospective data are currently available.

CONCLUSIONS: Participants with ROSC after CPR have statistically higher levels of ETCO₂. The average ETCO₂ level of 25 mm Hg in participants with ROSC is notably higher than the threshold of 10 to 20 mm Hg to improve delivery of chest compressions. The ETCO₂ goals during resuscitation may be higher than previously suggested and further investigation into appropriate targets during resuscitation is needed to diminish morbidity and mortality after cardiorespiratory arrest.

KEYWORDS: capnography; end-tidal carbon dioxide; meta-analysis; mortality; resuscitation

PMID: 24756307 [PubMed - as supplied by publisher]
Clinical paper

Cardiac arrest in the catheterisation laboratory: A 5-year experience of using mechanical chest compressions to facilitate PCI during prolonged resuscitation efforts

Henrik Wagner\textsuperscript{a},Christian J. Terkelsen\textsuperscript{b}, Hars Friberg\textsuperscript{c}, Jan Harne\textsuperscript{a}, Karl Kem\textsuperscript{d}, Jens Flensl\textsuperscript{a}, Goran K. Ollivcrona\textsuperscript{a}
Post Arrest Management
MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

THE HYPOTHERMIA AFTER CARDIAC ARREST STUDY GROUP

MMH/EMA
Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

Niklas Nielsen, M.D., Ph.D., Jørn Wetterslev, M.D., Ph.D., Tobias Cronberg, M.D., Ph.D., David Erlinge, M.D., Ph.D., Yvan Gasche, M.D., Christian Hassager, M.D., D.M.Sc., Janneke Horn, M.D., Ph.D., Jan Hovdenes, M.D., Ph.D., Jesper Kjaergaard, M.D., D.M.Sc., Michael Kuiper, M.D., Ph.D., Tommaso Pellis, M.D., Pascal Stammert, M.D., Michael Wanscher, M.D., Ph.D., Matt P. Wise, M.D., D.Phil., Anders Åneman, M.D., Ph.D., Nawaf Al-Subaie, M.D., Søren Boesgaard, M.D., D.M.Sc., John Bro-Jeppesen, M.D., Iole Brunetti, M.D., Jan Frederik Bugge, M.D., Ph.D., Christopher D. Hingston, M.D., Nicole P. Juffermans, M.D., Ph.D., Matty Koopmans, R.N., M.Sc., Lars Kober, M.D., D.M.Sc., Jorund Langørgen, M.D., Gisela Lilja, O.T., Jacob Eifer Møller, M.D., D.M.Sc., Malin Rundgren, M.D., Ph.D., Christian Rylander, M.D., Ph.D., Ondrej Smid, M.D., Christophe Werer, M.D., Per Winkel, M.D., D.M.Sc., and Hans Friberg, M.D., Ph.D., for the TTM Trial Investigators*
Advanced Cardiac Arrest

MMH/EMA
Clinical Paper

Myocardial infarction is a frequent cause of exercise-related resuscitated out-of-hospital cardiac arrest in a general non-athletic population

Helle Soholm a,*, Jesper Kjaergaard a, Jakob Hartvig Thomsen a, John Bro-Jeppesen a, Freddy K. Lippert b, Lars Køber a, Michael Wanscher c, Christian Hassager a

a Department of Cardiology 2142, The Heart Centre, Copenhagen University Hospital Rigshospitalet, Denmark
b Emergency Medical Services, Copenhagen, The Capital Region of Denmark, Denmark
c Department of Cardiothoracic Anesthesia 4142, The Heart Centre, Copenhagen University Hospital Rigshospitalet, Denmark

ABSTRACT

Background: Performing exercise is shown to prevent cardiovascular disease, but the risk of an out-of-hospital cardiac arrest (OHCA) is temporarily increased during strenuous activity. We examined the etiology and outcome after successfully resuscitated OHCA during exercise in a general non-athletic population.

Methods: Consecutive patients with OHCA were admitted with return of spontaneous circulation (ROSC) or on-going resuscitation at hospital arrival (2002–2011). Patient charts were reviewed for post-resuscitation data. Exercise was defined as moderate/vigorous physical activity.

Results: A total of 1383 OHCA patients were included with 917 (7%) arrests occurring during exercise. Exercise-related OHCA patients were younger (60 ± 13 vs. 65 ± 15, p < 0.001) and predominantly male (96% vs. 69%, p < 0.001). The arrest was more frequently witnessed (94% vs. 86%, p = 0.02), bystander CPR was more often performed (88% vs. 54%, p < 0.001), time to ROSC was shorter (12 min (IQR: 5–19) vs. 15 (9–22), p = 0.007) and the primary rhythm was more frequently shock able (91% vs. 49%, p < 0.001) compared to non-exercise patients. Cardiac etiology was the predominant cause of OHCA in both exercise and non-exercise patients (97% vs. 80%, p < 0.001) and acute coronary syndrome was more frequent among exercise patients (59% vs. 38%, p < 0.001). One-year mortality was 25% vs. 65% (p < 0.001), and exercise was even after adjustment associated with a significantly lower mortality (HR = 0.40 (95%CI: 0.23–0.72), p = 0.002).

Conclusions: OHCA occurring during exercise was associated with a significantly lower mortality in successfully resuscitated patients even after adjusting for confounding factors. Acute coronary syndrome was more common among exercise-related cardiac arrest patients.
Clinical paper

Cardiac catheterization is associated with superior outcomes for survivors of out of hospital cardiac arrest: Review and meta-analysis

Anthony C. Camuglia, Varinder K. Randhawa, Shahar Lavi, Darren L. Walters

A.C. Camuglia et al. / Resuscitation 85 (2014) 1533-1540

<table>
<thead>
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<th>Study or Subgroup</th>
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<td>Waldo 2013</td>
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<tr>
<td>Zanuttini 2012</td>
<td>33</td>
<td>48</td>
<td>21</td>
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</tbody>
</table>

Total (95% CI)        | 1752   | 2048  | 100.0% | 2.77 [2.06, 3.72] |

Total events          | 1031   | 632   |        |                  |

Heterogeneity: $\tau^2 = 0.20$; $\text{Chi}^2 = 43.27$, df = 14 ($P < 0.0001$); $I^2 = 68$
Test for overall effect: $Z = 6.79$ ($P < 0.00001$)

Fig. 2. Weighted hazard effects model of the relationship between acute coronary angiography and survival after OHCA.
Early cardiac catheterization is associated with improved survival in comatose survivors of cardiac arrest without STEMI

Ryan D. Hollenbeck, John A. McPherson, Michael R. Mooney, Barbara T. Unger, Nainesh C. Patel, Paul W. McMullan Jr., Chiu-Hsieh Hsu, David B. Seder, Karl B. Kern

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ABSTRACT
Atm: To determine if early cardiac catheterization (CC) is associated with improved survival in comatose patients who are resuscitated after cardiac arrest when electrocardiographic evidence of ST-elevation myocardial infarction (STEMI) is absent.

Methods: We conducted a retrospective observational study of a prospective cohort of 754 consecutive comatose patients treated with therapeutic hypothermia (TH) following cardiac arrest.

Results: A total of 260 (35.7%) patients had cardiac arrest due to a ventricular arrhythmia without STEMI and were treated with TH. Of these, 122 (45.4%) received CC while comatose (early CC). Acute coronary occlusion was discovered in 26.6% of patients treated with early CC compared to 29.3% of patients treated with late CC (p = 0.381). Patients treated with early CC were more likely to survive to hospital discharge compared to those not treated with CC (65.6% vs. 48.6%; p = 0.017). In a multivariate regression model that included study site, age, bystander CPR, shock on admission, comorbid medical conditions, witnessed arrest, and time to return of spontaneous circulation, early CC was independently associated with a significant reduction in the risk of death (OR 0.35, 95% CI 0.18–0.70, p = 0.003).

Conclusions: In comatose survivors of cardiac arrest without STEMI who are treated with TH, early CC is associated with significantly decreased mortality. The incidence of acute coronary occlusion is high, even when STEMI is not present on the postresuscitation electrocardiogram.

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Early coronary angiography and induced hypothermia are associated with survival and functional recovery after out-of-hospital cardiac arrest


Background: The rate and effect of coronary interventions and induced hypothermia after out-of-hospital cardiac arrest (OHCA) are unknown. We measured the association of early (≤24 h after arrival) coronary angiography, reperfusion, and induced hypothermia with favorable outcome after OHCA.

Methods: We performed a secondary analysis of a multicenter clinical trial (NCT00394706) conducted between 2007 and 2009 in 10 North American regions. Subjects were adults (≥18 years) hospitalized after OHCA with pulses sustained ≥60 min. We measured the association of early coronary catheterization, percutaneous coronary intervention, fibrinolysis, and induced hypothermia with survival to hospital discharge with favorable functional status (modified Rankin Score ≤3).

Results: From 16,875 OHCA subjects, 3981 (23.6%) arrived at 151 hospitals with sustained pulses. 1317 (33.1%) survived to hospital discharge, with 1006 (25.3%) favorable outcomes. Rates of early coronary catheterization (19.2%), coronary reperfusion (17.7%) or induced hypothermia (39.3%) varied among hospitals, and were higher in hospitals treating more subjects per year. Odds of survival and favorable outcome increased with hospital volume (per 5 subjects/year OR 1.06; 95%CI: 1.01-1.12 and OR 1.06; 95%CI: 1.01-1.12, respectively). Survival and favorable outcome were independently associated with early coronary angiography (OR 1.69; 95%CI 1.06-2.60 and OR 1.87; 95%CI 1.15-3.04), coronary reperfusion (OR 1.94; 95%CI 1.34-2.82 and OR 2.14; 95%CI 1.46-3.14), and induced hypothermia (OR 1.36; 95%CI 1.01-1.83 and OR 1.42; 95%CI 1.04-1.94).

Interpretation: Early coronary intervention and induced hypothermia are associated with favorable outcome and are more frequent in hospitals that treat higher numbers of OHCA subjects per year.

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SUMMARY: Post Arrest Management in 2013

- Patient should be taken to a 24/7 cardiac interventional center
- Lower FIO2 as soon as possible
- Normal pCO2
- SBP to 120mmHg with pressor
- Sedate
- Maintain 36C
- Prognosticate day 5
- Cath lab on ECMO or LUCAS2 if refractory arrest

Photo by Brian Burns
Poor Prognosis

- absent pupillary response at 72 hours
- absent corneal reflex at 72 hours
- no motor response or extension to pain at 72 hours (i.e. worse than flexion)
- myoclonic status epilepticus (MSE); ie. generalized myoclonic convulsions in face and extremities and continuous for a minimum of 30 min
- bilateral absence of cortical SSEPs (N20 response) at 1 to 3 days
- serum neuron-specific enolase >33 μg/L at 1 to 3 days
Less useful

- no CPR for > 8 minutes
- time to ROSC > 30 minutes
- duration of anoxic coma > 72 hours
- Burst suppression or generalized epileptiform discharges on EEG

http://lifeinthefastlane.com/ccc/prognosis-after-cardiac-arrest/
Good prognosis

- recovery of brainstem reflexes within 48 hours (papillary, corneal, oculocephalic)
- return of purposeful response within 24 hours
- primary pulmonary event leading to hypoxaemia
- hypothermia at time of arrest (emersion)
- young age

http://lifeinthefastlane.com/ccc/prognosis-after-cardiac-arrest/
Clinical Paper

Bispectral Index to Predict Neurological Outcome Early After Cardiac Arrest

Pascal Stammert, Olivier Collignon, Christophe Werer, Claude Sertznig, Yvan Devaux

Aims of the study: To address the value of continuous monitoring of bispectral index (BIS) to predict neurological outcome after cardiac arrest.

Methods: In this prospective observational study in adult comatose patients treated by therapeutic hypothermia after cardiac arrest we measured bispectral index (BIS) during the first 24 hours of intensive care unit stay. A blinded neurological outcome assessment by cerebral performance category (CPC) was done 6 months after cardiac arrest.

Results: Forty-six patients (48%) had a good neurological outcome at 6-month, as defined by a cerebral performance category (CPC) 1-2, and 50 patients (52%) had a poor neurological outcome (CPC 3-5). Over the 24 h of monitoring, mean BIS values over time were higher in the good outcome group (38±9) compared to the poor outcome group (17±12) (p<0.001). Analysis of BIS recorded every 30 minutes provided an optimal prediction after 12.5 h, with an area under the receiver operating characteristic curve (AUC) of 0.89, a specificity of 89% and a sensitivity of 86% using a cut-off value of 2.3. With a specificity fixed at 100% (sensitivity 26%), the cut-off BIS value was 2.4 over the first 271 minutes. In multivariable analyses including clinical characteristics, mean BIS value over the first 12.5 h was a predictor of neurological outcome (p=6E-6) and provided a continuous net reclassification index of 1.28% (p=4E-10) and an integrated discrimination improvement of 0.31 (p=1E-10).

Conclusions: Mean BIS value calculated over the first 12.5 h after ICU admission potentially predicts 6-month neurological outcome after cardiac arrest.

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Arrest Management of the Future
Remote Ischemic Conditioning

The ideal patient:

- About to undergo elective surgery with interruption of coronary circulation;
- Age < 65 years, without diabetes, stable angina or peripheral arterial disease;
- Not taking drugs that interfere with the mechanisms of preconditioning, including sulfonylureas, nitrates, and propofol.

I | R | I | R | I | R | I | R | Surgery

5 min
5 min
5 min
5 min
5 min
5 min
5 min
5 min

Four cycles of limb ischemia-reperfusion
Remote ischaemic conditioning before hospital admission, as a complement to angioplasty, and effect on myocardial salvage in patients with acute myocardial infarction: a randomised trial

Hans Erik Bækker, Rajesh Kharkanda, Michael R Schmidt, Morten Baitcher, Anne K Kaltoft, Christian J Terkelsen, Kim Munk, Niels H Andersen, Troels M Hansen, Sven Trautner, Jens Frensted Lassen, Evald Høj Christiansen, Lars R Krussel, Steen D Kristensen, Leif Thuesen, Søren S Nielsen, Michael Rehling, Henrik Toft Sørensen, Andrew N Redington, Torsten T Nielsen
Improved long-term clinical outcomes in patients with ST-elevation myocardial infarction undergoing remote ischaemic conditioning as an adjunct to primary percutaneous coronary intervention

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Cardioprotective Role of Remote Ischemic Perconditioning in Primary Percutaneous Coronary Intervention

Enhancement by Opioid Action

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Figure 2. Primary End Point Achievement per Group

Number of patients showing full resolution (≥80%) of ST-segment deviation after percutaneous coronary intervention in each randomization group. The difference was significant for both Groups A and B, when compared to the control group (p = 0.045 in the Kruskal-Wallis test; p = 0.015 in the Jonckheere-Terpstra test). Slightly more patients in Group B than in Group A achieved full resolution, but the difference between these 2 groups was insignificant. Resolution of ST-segment changes: orange bars = incomplete resolution; green bars = full resolution.
Clinical Paper

Feasibility study of immediate pharyngeal cooling initiation in cardiac arrest patients after arrival at the emergency room


MMH/EMA
Short communication

Chest compressions may be safe in arresting patients with left ventricular assist devices (LVADs)

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Extracorporeal life support as rescue strategy for out-of-hospital and emergency department cardiac arrest

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Abstract

Background: Extracorporeal life support (ECLS) has been utilized as a rescue strategy for patients with cardiac arrest unresponsive to conventional cardiopulmonary resuscitation.

Objective: We sought to describe our institution’s experience with implementation of ECLS for out-of-hospital and emergency department (ED) cardiac arrests. Our primary outcome was survival to hospital discharge.

Methods: Consecutive patients placed on ECLS in the ED or within one hour of admission after out-of-hospital or ED cardiac arrest were enrolled at two urban academic medical centers in the United States from July 2007 to April 2014.

Results: During the study period, 26 patients were included. Average age was 40 ± 15 years, 54% were male, and 42% were white. Initial cardiac rhythms were ventricular fibrillation or pulseless ventricular tachycardia in 42%. The average time from initial cardiac arrest to initiation of ECLS was 77 ± 51 min (range 12–180 min). ECLS cannulation was unsuccessful in two patients. Eighteen (69%) had complications related to ECLS, most commonly bleeding and ischemic events. Four patients (15%) survived to discharge, three of whom were neurologically intact at 6 months.

Conclusion: ECLS shows promise as a rescue strategy for refractory out-of-hospital or ED cardiac arrest but is not without challenges. Further investigations are necessary to refine the technique, patient selection, and ancillary therapeutics.
Clinical paper

Emergency physician-initiated extracorporeal cardiopulmonary resuscitation

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ABSTRACT

Objective: To determine whether emergency physicians could successfully incorporate ECPR into the resuscitation of patients who present to the emergency department (ED) with cardiopulmonary collapse refractory to traditional resuscitative efforts.

Context: Extracorporeal cardiopulmonary resuscitation (ECPR) refers to emergent percutaneous veno-arterial cardiopulmonary bypass to stabilize and provide temporary support of patients who suffer cardiopulmonary arrest. Initiation of ECPR by emergency physicians with meaningful long-term patient survival has not been demonstrated.

Design: A three-stage algorithm was developed for ED ECPR in patients meeting inclusion/exclusion criteria. We report a case series describing our experience with this algorithm over a 1-year period.

Results: 42 patients presented to our ED with cardiopulmonary collapse over the 1-year study period. Of these, 18 patients met inclusion/exclusion criteria for the algorithm. 8 patients were admitted to the hospital after successful ED ECPR and 5 of those patients survived to hospital discharge neurologically intact. 10 patients were not started on bypass support because either their clinical conditions improved or resuscitative efforts were terminated.

Conclusion: Emergency physicians can successfully incorporate ED ECPR in the resuscitation of patients who suffer acute cardiopulmonary collapse. More studies are necessary to determine the true efficacy of this therapy.

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Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

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Summary

Background Extracorporeal life-support as an adjunct to cardiac resuscitation has shown encouraging outcomes in patients with cardiac arrest. However, there is little evidence about the benefit of the procedure compared with conventional cardiopulmonary resuscitation (CPR), especially when continued for more than 10 min. We aimed to assess whether extracorporeal CPR was better than conventional CPR for patients with in-hospital cardiac arrest of cardiac origin.

Methods We did a 3-year prospective observational study on the use of extracorporeal life-support for patients aged 18–75 years with witnessed in-hospital cardiac arrest of cardiac origin undergoing CPR of more than 10 min compared with patients receiving conventional CPR. A matching process based on propensity-score was done to equalise potential prognostic factors in both groups, and to formulate a balanced 1:1 matched cohort study. The primary endpoint was survival to hospital discharge, and analysis was by intention to treat. This study is registered at ClinicalTrials.gov, number NCT0173615.

Findings Of the 975 patients with in-hospital cardiac arrest events who underwent CPR for longer than 10 min, 113 were enrolled in the conventional CPR group and 59 were enrolled in the extracorporeal CPR group. Unmatched patients who underwent extracorporeal CPR had a higher survival rate to discharge (log-rank p=0.001) and a better 1-year survival than those who received conventional CPR (log rank p=0.007). Between the propensity-score matched groups, there was still a significant difference in survival to discharge (hazard ratio [HR] 0.51, 95% CI 0.35–0.74, p<0.001), 30-day survival (HR 0.47, 95% CI 0.28–0.77, p=0.003), and 1-year survival (HR 0.33, 95% CI 0.33–0.83, p<0.001) favouring extracorporeal CPR over conventional CPR.

Interpretation Extracorporeal CPR had a short-term and long-term survival benefit over conventional CPR in patients with in-hospital cardiac arrest of cardiac origin.

Introduction Sudden cardiac arrest still has a low survival rate despite the introduction of cardiopulmonary resuscitation (CPR),1 and this rate has remained unchanged since 1992.12 Interventions have also shown that patients who received CPR of more than 10 min. We also aimed to assess whether the survival benefit of extracorporeal CPR over conventional CPR seen in previous studies13 might have been due to selection bias.
Early Induction of Hypothermia During Cardiac Arrest Improves Neurological Outcomes in Patients With Out-of-Hospital Cardiac Arrest Who Undergo Emergency Cardiopulmonary Bypass and Percutaneous Coronary Intervention

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Background: Therapeutic hypothermia for comatose survivors of out-of-hospital cardiac arrest has demonstrated neurological benefits. Although early cooling during cardiac arrest enhances efficacy in animal studies, few clinical studies are available.

Methods and Results: The 171 patients who failed to respond to conventional cardiopulmonary resuscitation were studied prospectively. Patients underwent emergency cardiopulmonary bypass (CPB) plus intra-aortic balloon pumping, with subsequent percutaneous coronary intervention (PCI) if needed. Mild hypothermia (34°C for 3 days) was induced during cardiac arrest or after return of spontaneous circulation. Of the 171 patients, 21 (12.3%) had a favorable neurological outcome at hospital discharge. An unadjusted rate of favorable outcome decreased in a stepwise fashion for increasing quartiles of collapse-to-34°C interval (P=0.016). An adjusted odds ratio for favorable outcome after collapse-to-CPB interval was 0.89 (95% confidence interval [CI] 0.82–0.97) and after CPB-to-34°C interval, 0.90 (95%CI 0.85–0.95) when collapse-to-34°C interval was divided into 2 components. Favorable neurological accuracy of a collapse-to-CPB interval at a cutoff of 55.5 min and CPB-to-34°C interval at a cutoff of 21.5 min was 85.4% and 95.8%, respectively.

Conclusions: Early attainment of a core temperature had neurological benefits for patients with out-of-hospital cardiac arrest who underwent CPB and PCI.

Key Words: Cardiac arrest; Cardiopulmonary bypass; Cardiopulmonary resuscitation; Extracorporeal circulation; Hypothermia
Clinical paper

Safety and feasibility of prehospital extra corporeal life support implementation by non-surgeons for out-of-hospital refractory cardiac arrest

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Abstract

Background: Extra corporeal life support (ECLS) has been recently introduced in the treatment of refractory cardiac arrest (CA). Several studies have assessed the use of ECLS in refractory CA once the patient has reached hospital. The time between CA and the implementation of ECLS is a major prognostic factor for survival. The main predictive factor for survival is ECLS access time. Pre-hospital ECLS implementation could reduce access time. We therefore decided to assess the feasibility and safety of prehospital ECLS implementation (PH-ECLS) in a pilot study.

Methods and results: From January 2011 to January 2012, PH-ECLS implementation for refractory CA was performed in 7 patients by a PH-ECLS team including emergency and/or intensivist physicians and paramedics. Patients were included prospectively and consecutively if the following criteria were met: they had a witnessed CA; CPR was initiated within the first 5 min of CA and/or there were signs of life during CPR; an PH-ECLS team was available and absence of severe comorbidities. ECLS flow was established in all patients. ECLS was started 22 min (±6) after the incidence and 57 min (±21) after the onset of advanced cardiovascular life support (ACLS). In one patient, ECLS was stopped for 10 min due to an accidental decannulation. One patient survived without sequelae. Three patients developed brain death.

Conclusions: This pilot study suggests that PH-ECLS performed by non-surgeons is safe and feasible. Further studies are needed to confirm the time saved by this strategy and its potential effect on survival.
Clinical Paper

Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: A prospective observational study

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ARTICLE INFO

Article history:

ABSTRACT

Background: A favorable neurological outcome is likely to be achieved in out-of-hospital cardiac arrest
Clinical Paper

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

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Statewide Regionalization of Postarrest Care for Out-of-Hospital Cardiac Arrest: Association With Survival and Neurologic Outcome

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Sodium nitroprusside enhanced cardiopulmonary resuscitation improves survival with good neurological function in a porcine model of prolonged cardiac arrest*

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Objective: To assess the effectiveness of sodium nitroprusside (SNP)-“enhanced” cardiopulmonary resuscitation (SNPeCPR) on 24-hr survival rates compared to standard CPR in animals after cardiac arrest. SNPeCPR consists of large intravenous SNP bolus doses during CPR enhanced by active compression-decompression CPR, an inspiratory impedance threshold device (ITD), and abdominal binding (AB). The combination of active compression-decompression CPR+ITD+AB without SNP will be called “enhanced” or eCPR.

Design: Randomized, blinded, animal study.

Setting: Preclinical animal laboratory.

Subjects: Twenty-four female farm pigs (30 ± 1 kg).

Interventions: Isoflurane anesthetized and intubated pigs were randomized after 8 mins of untreated ventricular fibrillation to receive either standard CPR (n = 8), SNPeCPR (n = 8), or eCPR (n = 8) for 25 mins followed by defibrillation.

Measurements and Main Results: The primary end point was carotid blood flow during CPR and 24-hr survival with good neurologic function defined as an overall performance category score of ≤2 (1 = normal, 5 = brain dead or dead). Secondary end points included hemodynamics and end-tidal CO₂. SNPeCPR significantly improved carotid blood flow and 24-hr survival rates with good neurologic function compared to standard CPR or eCPR (six of eight vs. zero of eight vs. one of eight, p < .05). The improved survival rates were associated with higher coronary perfusion pressure and ETCO₂ during CPR.

Conclusion: In pigs, SNPeCPR significantly improved hemodynamics, resuscitation rates, and 24-hr survival rates with good neurologic function after cardiac arrest when compared with standard CPR or eCPR alone. (Crit Care Med 2011; 39:1269–1274)

Key Words: vasodilators; cardiopulmonary resuscitation; neurological function; resuscitation rates; carotid blood flow
Sodium nitroprusside enhanced cardiopulmonary resuscitation prevents post-resuscitation left ventricular dysfunction and improves 24-hour survival and neurological function in a porcine model of prolonged untreated ventricular fibrillation

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A R T I C L E   I N F O

Keywords:
Cardiopulmonary resuscitation
Left ventricular function
Neurological function
Survival
Vasodilation

A B S T R A C T

Aim of study: Sodium nitroprusside-enhanced CPR, or SNP-CPR, consists of active compression-decompression CPR with an impedance threshold device, abdominal compression, and intravenous sodium nitroprusside (SNP). We hypothesize that SNP-CPR will improve post resuscitation left ventricular function and neurological function compared to standard (S) CPR after 15 min of untreated ventricular fibrillation in a porcine model of cardiac arrest.

Methods: Pigs (n = 22) anesthetized with isoflurane underwent 15 min of untreated ventricular fibrillation, were then randomized to 6 min of S-CPR (n = 11) or SNP-CPR (n = 11) followed by defibrillation. The primary endpoints were neurological function as measured by cerebral performance category (CPC) score and left ventricular ejection fraction.

Results: SNP-CPR increased 24-hour survival rates compared to S-CPR (10/11 versus 5/11, p = 0.03) and improved neurological function (CPC score 2.5 ± 1, versus 3.8 ± 0.4, respectively, p = 0.004). Left ventricular ejection fractions at 1, 4 and 24 hours after defibrillation were 72 ± 11, 57 ± 11.4 and 64 ± 11 with SNP-CPR versus 29 ± 10, 30 ± 17 and 39 ± 6 with S-CPR, respectively (p < 0.01 for all).

Conclusions: In this pig model, after 15 min of untreated ventricular fibrillation, SNP-CPR significantly improved 24-hour survival rates, neurological function and prevented post-resuscitation left ventricular dysfunction compared to S-CPR.

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Sequential Invasive Resuscitation Interventions in Medical/Non-Trauma Cardiac Arrest

If initial CPR, Defibrillation, ACLS is unsuccessful (No ROSC)

Femoral artery SAAP balloon catheter insertion & initiate **SAAP with O₂ carrier** (HBOC, PFC, WB/pRBC) 
(obtain venous access during this initial SAAP phase)

*If ROSC not achieved*, venous blood W/D & transition to **SAAP with Autologous Blood** (partial ECMO/ECLS)

*If ROSC not achieved*, larger femoral arterial cannula & convert to **whole body ECLS/ECPR**

*If ROSC not achieved*, **Consider**: Cardiac Cath for PCI, LVAD, VIR, CT/Vasc Surgery, profound hypothermia (?), and cessation of resuscitation efforts

The Bottom Line - Airway

- Delay definitive airway management until after ROSC
- DO NOT stop compressions for airway
  - BVM (+) OPA may be superior

http://www.atitesting.com/ati_next_gen/skillsmodules/content/airway-management/equipment/devices.html
The Bottom Line - Breathing

- Use low tidal volumes
- Use RR of 6 – 10
- Can use ventilator
- ITD
- DO NOT STOP COMPRESSIONS FOR VENTILATION
The Bottom Line - Circulation

• Minimize time off chest ratio - > 80%
• Only hands off time is for defibrillation (maybe) and rhythm analysis
  • CHARGE DEFIB PRIOR TO RHYTHM ANALYSIS
  • Use End-Tidal CO2 to guide compression quality
  • Treat refractory VF with DSED or beta blockade
• Target a diastolic BP > 25 mm hg with vasopressors
  • Mechanical CPR in ambulance and cath lab
    • Immediate CPR post shock
      • “Consider” drugs
        • ECMO
The Bottom Line – Post-Arrest

- Therapeutic hypothermia
- STRONGLY consider cath lab for OOHCA
  - Maintain hemodynamics
    - Sedate
- CANNOT PROGNOSTICATE ANYONE